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January 1995



Biology 30
Grade 12 Diploma Examination

Alberta
EDUCATION

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January 1995

Biology 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

Total possible marks: 80

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions each with a value of one mark
- 2 written-response questions, each worth 12 marks

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar will be used to indicate the end of a set.

Tear-out data pages are included at the back of this booklet.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A. biology
- B. physics
- C. chemistry
- D. science

Answer Sheet

☒ (B) (C) (D)

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Record your answer to three significant digits in the numerical-response section of the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7 \text{ (rounded to three digits)}\end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
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<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
(0)	(0)	(0)	(0)
(1)	(1)	(1)	(1)
(2)	(2)	(2)	(2)
(3)	(3)	(3)	(3)
(4)	(4)	(4)	(4)
(5)	(5)	(5)	(5)
(6)	(6)	(6)	(6)
(7)	(7)	(7)	(7)
(8)	(8)	(8)	(8)
(9)	(9)	(9)	(9)

Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record your four-digit answer on the numerical-response section of the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the answer sheet →

3	2	1	4
•	•		
0	0	0	0
1	1	•	1
2	•	2	2
•	3	3	3
4	4	4	•
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Selection Question and Solution

The birds in the following list are numbered _____.
(Record your answer in ascending numerical order in the numerical-response section of the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

Record 245 on the answer sheet →

2	4	5	
•	•		
0	0	0	0
1	1	1	1
•	2	2	2
3	3	3	3
4	•	4	4
5	5	•	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

Do not turn the page to start the examination until told to do so by the presiding examiner.



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Scientists study disorders of the nervous and endocrine system to find treatments for the disorders and to extend their knowledge of these systems.

Use the following information to answer the next two questions.

Alzheimer's disease is a degenerative, incurable, and often fatal brain disorder. It is characterized by progressive memory loss and the inability to think, speak, or perform basic tasks.

Autopsy studies of the brain tissue of Alzheimer's patients usually show abnormalities such as:

- tangled and twisted protein filaments within neuron cell bodies
- clusters of degenerated axon terminals
- death of certain neurons that are responsible for the production of a common neurotransmitter
- growth within neurons of patches composed of a protein called beta-amyloid

1. Within a neuron, the production of beta-amyloid patches is primarily controlled by substances in the
 - A. myelin sheath
 - B. cell body
 - C. dendrite
 - D. axon

2. Which secretion is most likely lacking in the brain of an Alzheimer's patient?
 - A. ATP
 - B. Acetylcholine
 - C. Transfer RNA
 - D. Cholinesterase

Use the following information to answer the next two questions.

Huntington Disease

Many genetic disorders in humans result in some behavioural abnormality. One example is Huntington disease (HD), which is controlled by the presence of a dominant gene. This disease affects all parts of the nervous system, including the brain. Symptoms of HD usually appear after age 40 and include a gradual loss of motor function and coordination. Degeneration of the nervous system is progressive and produces personality changes. Affected individuals become unable to care for themselves. These symptoms indicate that the disease affects some parts of the brain more than others.

3. Which row identifies the degree to which certain parts of the brain are most likely affected by HD?

Row	Relative Effect of HD on Parts of the Brain			
	Cerebrum	Cerebellum	Pituitary	Hypothalamus
A	slight	slight	significant	significant
B	significant	slight	significant	slight
C	slight	significant	slight	significant
D	significant	significant	slight	slight

Use this additional information to answer the next question.

A person with HD has elevated levels of quinolinic acid. Quinolinic acid is an amino acid that excites neurons but also acts as a neurotoxin (poison). It is produced when tryptophan is metabolized by the body.

4. This additional information supports the hypothesis that the gene that causes HD is
- A. a structural gene that contains information used to produce an enzyme that metabolizes tryptophan
 - B. a mutant gene that promotes the action of enzymes that metabolize quinolinic acid
 - C. a regulatory gene that produces an enzyme that metabolizes quinolinic acid
 - D. an oncogene that activates enzymes that metabolize tryptophan

Use the following list to answer the next question.

Some Events that Occur in the Nervous System

- 1 A motor neuron stimulates the effector.
- 2 Nerve tracts in the medulla oblongata are activated.
- 3 The brain interprets the sensation of pain.
- 4 A sensory neuron is depolarized.
- 5 A receptor is stimulated.
- 6 The motor cortex initiates movement.
- 7 An impulse is initiated in an interneuron.

Numerical Response

1. When a person's hand touches a very hot object, a reflex arc is activated, which causes the person to quickly withdraw the hand. Provide the correct sequence of events that occurs in this reflex arc by selecting **four** events from the list and arranging them in the proper order.

Answer:

First event

Second event

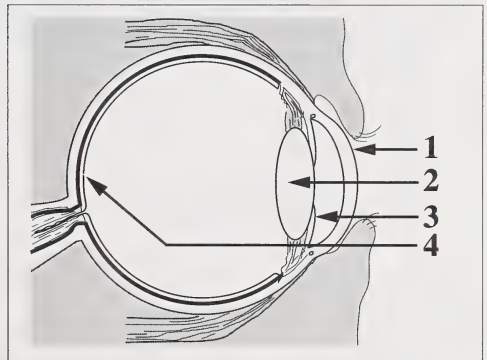
Third event

Fourth event

(Record your four-digit answer in the numerical-response section of the answer sheet.)

5. Many blind people have damaged sensory receptors in the eyes but undamaged optic nerves. To assist these people, an artificial eye would have to replace the function of which structure shown in the diagram at the right?

- A. 1
B. 2
C. 3
D. 4



6. An optometrist who wants to dilate the pupil to study the interior of the eye would likely administer a drug to stimulate the
- A. central nervous system
 - B. somatic nervous system
 - C. sympathetic nervous system
 - D. parasympathetic nervous system

Use the following information to answer the next two questions.

Damage to hair cells in the inner ear was thought to permanently impair the sense of balance. Recent research indicates that humans and guinea pigs have the ability to form new hair cells in the utricle. In experiments, these hair cells were chemically destroyed. After some time, new hair cells formed. These new cells eventually connected with neurons. Researchers have yet to discover the internal body stimuli that trigger the formation of the new cells.

7. In the experiments, newly formed hair cells connected with neurons. What type of neurons would these be?
- A. Motor neurons
 - B. Sensory neurons
 - C. Somatic neurons
 - D. Association neurons
8. In order to develop a procedure that would restore hearing in individuals with hearing loss caused by damage to hair cells, similar research must be done on the hair cells found in the
- A. sacculle
 - B. cochlea
 - C. auditory canal
 - D. semicircular canals
-
9. Both gigantism and dwarfism are disorders caused by a malfunction of which gland or glands?
- A. Gonads
 - B. Thyroid
 - C. Pituitary
 - D. Adrenals

Use the following information to answer the next question.

Possible Symptoms of Diabetes Mellitus

- 1 Increased insulin production
- 2 Decreased insulin production
- 3 Increased blood glucose level
- 4 Decreased blood glucose level
- 5 Increased cellular absorption of glucose
- 6 Decreased cellular absorption of glucose
- 7 Increased urine production
- 8 Decreased urine production

Numerical Response

- 2.** Pat, a 14 year-old student, has diabetes mellitus. Which four of these symptoms would Pat likely show, if untreated?

Answer: _____

(Record your four-digit answer in ascending numerical order in the numerical-response section of the answer sheet.)

- 10.** Which hormone acts antagonistically (oppositely) to insulin?

- A. Somatotropin
- B. Epinephrine
- C. Thyroxine
- D. Glucagon

Use the following information to answer the next three questions.

Amino Acid Sequence in Insulin

Dr. Frederick Sanger and his colleagues in England worked out the exact sequence of 51 amino acids in the insulin molecule. One part of that sequence of amino acids is:

— alanine — lysine — proline — threonine —

11. Which sequence of nitrogen bases in DNA encodes information to make this part of the insulin molecule?
- A. — CGA — TTT — GGT — TGA —
 - B. — CGT — AAA — GGT — ACT —
 - C. — GCU — AAA — CCA — ACU —
 - D. — GCG — AAG — CCA — ACG —
12. Which change in the structure of mRNA would **not** cause the amino acid threonine to be replaced with another amino acid?
- A. ACG → UCG
 - B. ACA → AUC
 - C. ACC → UGG
 - D. ACU → ACC
13. Although all normal human insulin molecules contain a specific sequence of amino acids, the nucleotide sequence in the insulin gene may vary slightly from person to person. This variation can occur because
- A. the type of amino acids in insulin does not affect its function
 - B. a specific amino acid can be represented by more than one codon
 - C. the sequence of amino acids in insulin does not affect its function
 - D. a specific codon can be represented by more than one polypeptide

Use the following information to answer the next question.

Scientists from the All India Institute of Medical Sciences in New Delhi recently conducted research on the reproductive endocrine functions of men with hypothyroidism. Their objective was to study the relationship between thyroid hormones (triiodothyronine and thyroxine)* and hormones related to reproduction. Eight men with symptoms of hypothyroidism were chosen for the study. Blood samples from these men were analyzed before treatment for hypothyroidism began. Some of the data are presented in table 1.

Table 1: Data Obtained from Eight Patients with Hypothyroidism and Normal Ranges of Some Hormone Concentrations in Blood

Patient	Age (years)	TSH (units)	Triiodothyronine (units)	Thyroxine (units)
1	43	>100	36.0	2.2
2	26	>100	32.0	0.0
3	45	>100	26.0	1.0
4	26	>100	28.0	0.5
5	55	>100	40.0	0.5
6	62	>100	50.0	3.0
7	37	>100	46.0	2.0
8	41	>100	0.7	0.7
Normal range	—	0–8	80–160	5–11

* Two thyroid hormones with similar functions

Written Response – 12 marks

- 1. a.** Based on the data in table 1, define hypothyroidism in terms of the function of the thyroid gland.

(1 mark)

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.....

- b.** Explain why TSH concentrations in the eight patients differed from the normal range?

(1 mark)

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Continued

(1 mark)

- c. Describe **one** possible treatment for hypothyroidism suggested by the data in table 1.

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(3 marks)

- d. Identify **three** symptoms of hypothyroidism, other than hormone concentrations in the blood or effects on reproduction, likely shown by the patients.

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Before treatment for hypothyroidism began, blood samples from the eight patients were tested for the presence of some hormones related to reproduction. Similar tests were performed after treatment for hypothyroidism was complete. A control group was tested in a similar manner. The average blood concentrations of these hormones related to reproduction are shown in table 2.

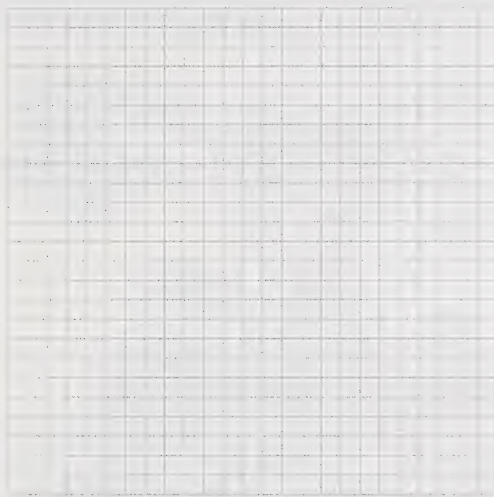
Table 2: Average Blood Concentrations of Some Hormones Related to Reproduction in Eight Patients Before and After Treatment for Hypothyroidism and in a Control Group

Group	Hormone Concentration (units/L of blood)		
	LH	FSH	Testosterone
Patients before treatment	19.0	6.0	5.5
Patients after treatment	7.0	3.0	13.0
Control	6.0	3.5	23.5

Continued

(3 marks)

- e. Draw a **bar graph** to illustrate the data in table 2.



- f. Why would a man with hypothyroidism produce fewer sperm than a man with a normally functioning thyroid?

(1 mark)

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- g. Explain the differences in the production of FSH and testosterone by the group of eight patients before treatment and by the control group.

(2 marks)

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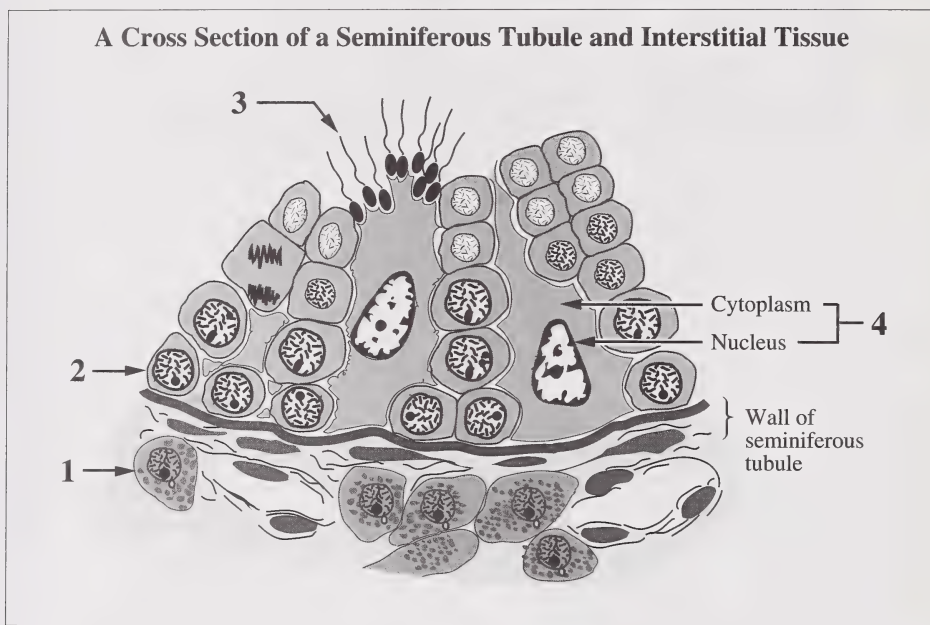
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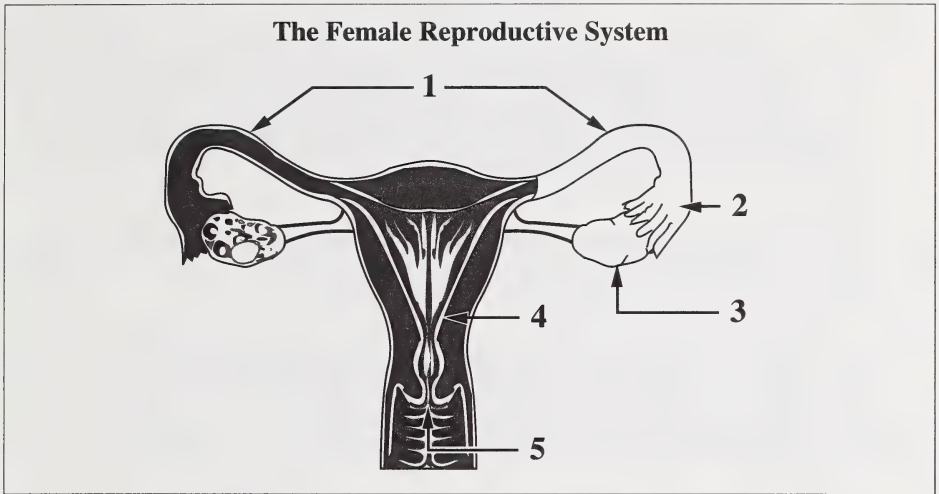
Reproductive processes may be affected by disease, the environment, or the use of technology.

Use the following diagram to answer the next two questions.



14. The sample of tissue used to make this cross section would be obtained from the
- A. testis
 - B. epididymis
 - C. vas deferens and urethra
 - D. seminal vesicle and prostate
15. The cell that contains a single X or Y chromosome is labelled
- A. 1
 - B. 2
 - C. 3
 - D. 4

Use the following information to answer the next three questions.



16. Complete blockage of both structures labelled 1 would prevent
- A. fertilization of eggs
 - B. development of follicles
 - C. movement of sperm into the uterus
 - D. secretion of estrogen and progesterone
17. Gonorrhea, a sexually transmitted disease, may cause an infection in the structure labelled 4. This condition could result in sterility because
- A. ovulation would be disrupted
 - B. menstruation would not occur
 - C. implantation would be prevented
 - D. fertilization would not be possible
18. Which structure produces a hormone that prevents uterine contraction during the first weeks of pregnancy?
- A. 2
 - B. 3
 - C. 4
 - D. 5

Use the following information to answer the next question.

A Reproductive Technology

Reproductive technology may be used when people have difficulty conceiving children.

In vitro fertilization (IVF) is a procedure in which eggs are removed from a woman's ovary and placed in a culture dish containing sperm from a male donor. After fertilization occurs, an embryo is inserted into the uterus through the vagina.

19. The female menstrual cycle has several phases. Implantation of the fertilized egg in the IVF procedure would have the greatest chance of success if it were done during the
- A. corpus luteal phase when progesterone levels are high
 - B. corpus luteal phase when FSH levels are high
 - C. follicular phase when estrogen levels are high
 - D. follicular phase when LH levels are high
-
20. Researchers have discovered that exposure to an electric field causes the caps (acrosomes) of sperm to burst before contact with ova. How might exposure of sperm to an electric field affect the success rate of *in vitro* fertilization?
- A. The success rate would improve because sperm would be more motile.
 - B. The success rate would decline because the nuclei of sperm would be altered.
 - C. The success rate would decline because sperm would not be able to penetrate ova.
 - D. The success rate would improve because more nutrients would be available to ensure survival of sperm.
21. In humans, a sperm and an egg are similar in that both
- A. require normal body temperature for maturation and development
 - B. contribute equally to the cytoplasm of the zygote
 - C. are inactivated by a solution with a pH of 7 to 9
 - D. contain the same number of chromosomes

22. Which statement about the events that occur during childbirth is correct?
- A. An increase in prolactin causes relaxation of pelvic ligaments.
 - B. An increase in oxytocin causes contraction of uterine muscles.
 - C. A decrease in estrogen causes contraction of abdominal muscles.
 - D. A decrease in progesterone causes relaxation of placental membranes.

Use the following information to answer the next three questions.

Fetal Alcohol Syndrome

Fetal Alcohol Syndrome (FAS) is a condition that develops in a fetus as a result of the ingestion of alcohol (ethanol) by a pregnant woman. The effects on the fetus include mental retardation, slow growth, and the development of a small head, narrow eye slits, and a defective heart. These changes are not reversible. Pregnant women who consume 25 mL of pure alcohol daily (equivalent to two or three bottles of beer) have a 2% chance of giving birth to a child with FAS.

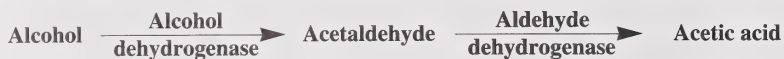
Most doctors urge pregnant patients to avoid the use of drugs of all kinds. The use of drugs such as alcohol, heroin, cocaine, and morphine may cause a child to be born addicted.

23. Some women who consume 25 mL of absolute alcohol daily may have a significantly higher than 2% risk of having a child with FAS. The additional factor that likely contributes most to this increased risk is a woman's
- A. body mass
 - B. emotional state
 - C. exercise routine
 - D. choice of brand of alcoholic beverage
24. An infant can be born with a drug addiction because
- A. a child can acquire all of its mother's habits
 - B. a child can inherit some of its mother's addictions
 - C. placental membranes promote the mixing of maternal blood with fetal blood
 - D. placental membranes are permeable to substances other than nutrients and wastes

Continued

Use this additional information to answer the next question.

Alcohol is normally metabolized as follows:



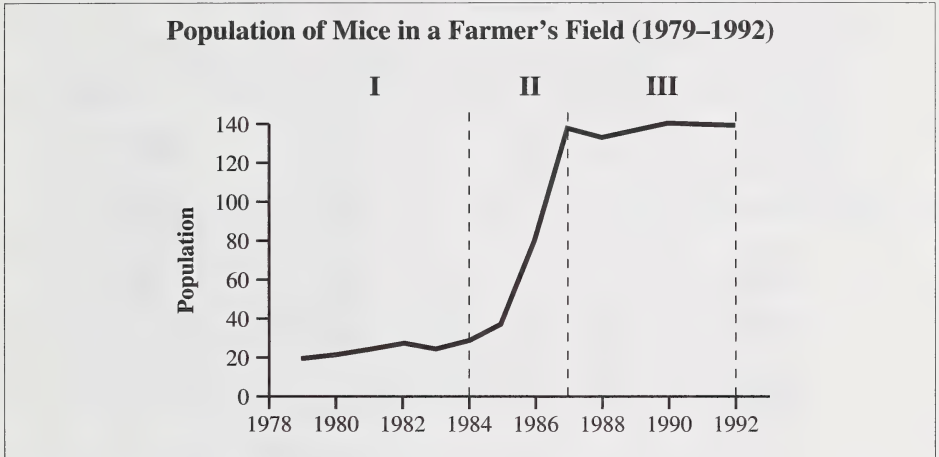
Acetaldehyde is a product of alcohol metabolism that contributes to fetal damage. Acetic acid may be used for energy production or fat synthesis.

25. Which row indicates the rate of action of two enzymes in a pregnant woman's body that would put a fetus at the greatest risk of developing FAS?

Row	Relative Rate of Action of Enzymes in a Pregnant Woman's Body	
	Alcohol dehydrogenase	Aldehyde dehydrogenase
A	fast	fast
B	fast	slow
C	slow	fast
D	slow	slow

Data collected by scientists reveal interactions among organisms and populations.

Use the following graph to answer the next two questions.

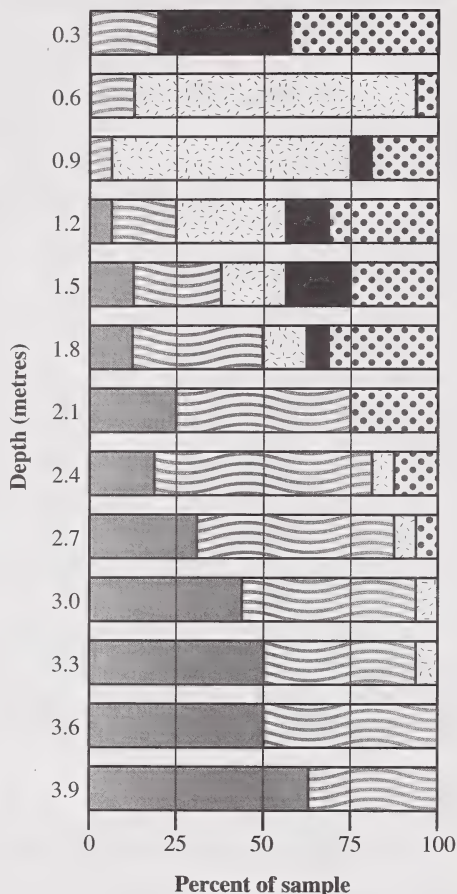


26. On the graph, sections I, II, and III respectively show the
- A. stationary phase, growth phase, and lag phase of a closed population
 - B. lag phase, growth phase, and stationary phase of a closed population
 - C. stationary phase, growth phase, and lag phase of an open population
 - D. lag phase, growth phase, and stationary phase of an open population
27. The trend shown in section II of the graph might have continued for an extra year if
- A. predators had been allowed to roam freely
 - B. irrigation had increased the growth of vegetation
 - C. more consumers had been added to the environment of the mice
 - D. traps had been set to prevent emigration and immigration of mice

Use the following information to answer the next three questions.

Historical plant populations can be examined by removing core samples of earth and microscopically examining them for the types of pollen present. The graph shows an analysis of pollen collected at various depths from a grassland site in southern Alberta. The samples were obtained by drilling into the earth and then removing the entire core sample intact. The total depth sampled has accumulated since the end of the last glacial period, approximately 13 000 years ago. Each 0.3 m of depth represents about 1 000 years.

Pollen Core Samples Taken from a Grassland Area in Southern Alberta



28. The change in the vegetation over the last 13 000 years is called

- A. succession
- B. colonization
- C. seral staging
- D. a climax community

Continued

29. Select the row that correctly identifies the sequence of communities this site has supported from 13 000 years ago up to and including the present.

Row	Sequence of Communities
A	Grass-deciduous → pine-spruce → pine → fir-spruce
B	Fir-spruce → pine-deciduous → pine → grass-deciduous
C	Pine-grass → pine-fir→ pine-spruce → spruce-deciduous
D	Grass-deciduous → pine → fir-spruce → spruce-pine

30. According to the data, in what way and when did the climate dramatically change in southern Alberta?

- A. The climate became warm and dry 12 000 to 13 000 years ago.
- B. The climate became cool and moist 7 000 to 8 000 years ago.
- C. The climate became cool and moist 3 000 to 4 000 years ago.
- D. The climate became warm and dry 1 000 to 2 000 years ago.

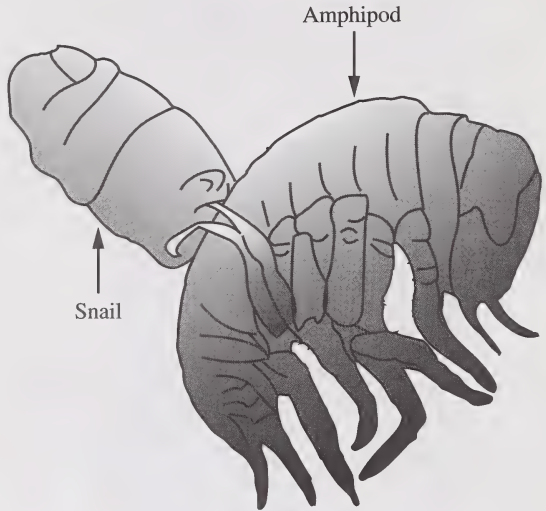
Use the following information to answer the next two questions.

In the Antarctic, James McClintock noticed that small amphipods (crustaceans) captured small free-floating snails. The snails were bright orange in colour and half the size of the amphipods. An amphipod held a snail on its back with 4 of its 14 legs. The snails were released unharmed when it got dark.

In a laboratory, McClintock separated populations of snails from populations of amphipods and placed some small fish with each group. The fish ate the amphipods but ate only a few of the snails and immediately spit them out.

When amphipods with snails on their backs were placed in the tank that originally contained snails, the fish did not eat the amphipods and actually avoided them. McClintock ground up some snails and formed them into pellets to feed the fish. When these pellets were fed to the fish, they immediately spit them out.

An Amphipod with a “Piggy-Back” Snail



31. The term that best describes the relationship between the amphipod and the snail is
- A. commensalism
 - B. mutualism
 - C. parasitism
 - D. predation
32. Why did the fish **not** eat the amphipods with snails on their backs?
- A. The snails provided camouflage for the amphipods.
 - B. The fish learned to avoid the amphipods because the amphipods mimicked the snails.
 - C. The foul taste of the snails was absorbed by the amphipods and the fish learned to avoid them.
 - D. The fish avoided eating amphipods carrying snails because they recognized the warning coloration.

Use the following information to answer the next four questions.

A Zebra Mussel Takeover

The European zebra mussel, a small bivalve mollusk, was first discovered in North America in 1988. It was found in Lake St. Clair, which connects Lake Huron to Lake Erie. By 1991, the mussel had spread to all the Great Lakes as well as the Illinois River. Scientists think the mussels were carried into the Great Lakes in the ballast water of freighters. During the summer of 1993, the Mississippi River flooded its banks and picked up zebra mussels from the Illinois River. The flood waters carried the mussels into creeks, lakes, and ponds along its southerly route.

Zebra mussels spawn up to five times a year and release about a million eggs per spawning. The larvae travel in water for five to 30 days before they settle onto something stationary. The mussels secrete strong threads that tether them to submerged rocks, docks, hulls of boats, and sewage and water treatment intake-pipes. As many as 94 000 zebra mussels can occupy a surface area of 1 m².

Zebra mussels feed by drawing water over their gills with siphons. They compete with native mussels and fish for suspended food such as algae. Natural predators, such as ducks and crayfish, have not been able to keep them under control. The use of chemical pesticides, such as chlorine, is costly and can lead to the formation of cancer-causing agents in water systems.

Map of Region Infested with Zebra Mussels



33. The abiotic factor that caused the zebra mussel to spread from the Great Lakes south into the United States rather than north into Canada was the difference in the
- A. diversity of predators in Canada and the United States
 - B. food supply in the waterways of the United States and Canada
 - C. level of industrial development of the United States and Canada
 - D. natural water drainage patterns of Canada and of the United States

Continued

34. The spread of the European zebra mussel in North America from 1988 through 1993 is an example of a species with populations that are distributed
- A. in clumps and K-selected
 - B. randomly and K-selected
 - C. in clumps and r-selected
 - D. randomly and r-selected

Numerical Response

3. Suppose that a population of 3 500 mussels occupied a rectangular territory 2.00 m by 2.00 m. Calculate the average density of this mussel population.

Answer: _____ /m²

(Record your answer to three significant digits in the numerical-response section of the answer sheet.)

Numerical Response

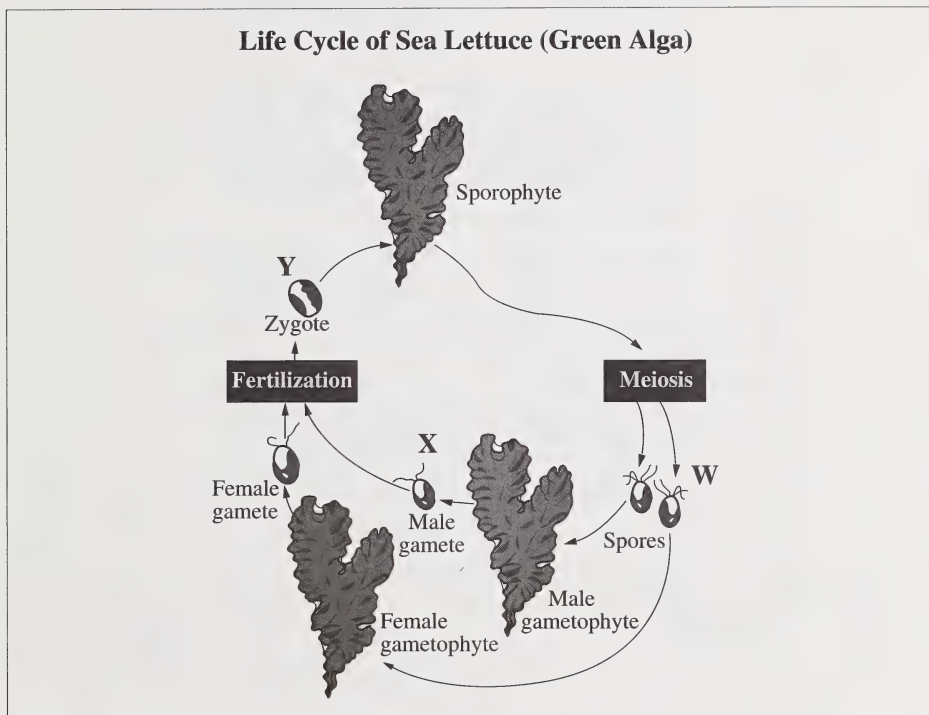
4. Given that one mussel releases one million eggs per spawning and assuming that the survival rate is 0.020%, calculate the maximum number of surviving individuals produced in two generations originating with one mussel. Express your answer in scientific notation in the form $w \times 10^y$ mussels. What is the value of w when the answer is expressed in scientific notation?

Answer: _____

(Record your answer to two significant digits in the numerical-response section of the answer sheet.)

An understanding of the principles of cell division and genetics is required to make appropriate choices about the use of biotechnology.

Use the following information to answer the next two questions.



35. Which conclusion about the life cycle of sea lettuce is supported by the diagram?
- The spore is diploid.
 - The zygote is haploid.
 - The sporophyte is diploid.
 - The gametophyte is diploid.
36. Assuming that the diploid chromosome number for this species is 12, what is the chromosome number at stages labelled W, X, and Y respectively?
- 6, 6, and 12
 - 6, 12, and 12
 - 6, 12, and 24
 - 12, 12, and 24

37. Compared to asexual reproduction, one advantage of sexual reproduction is the
- A. development of haploid individuals
 - B. development of genetically identical individuals
 - C. increased production of offspring in one life cycle
 - D. increased chance of producing offspring adaptable to environmental change

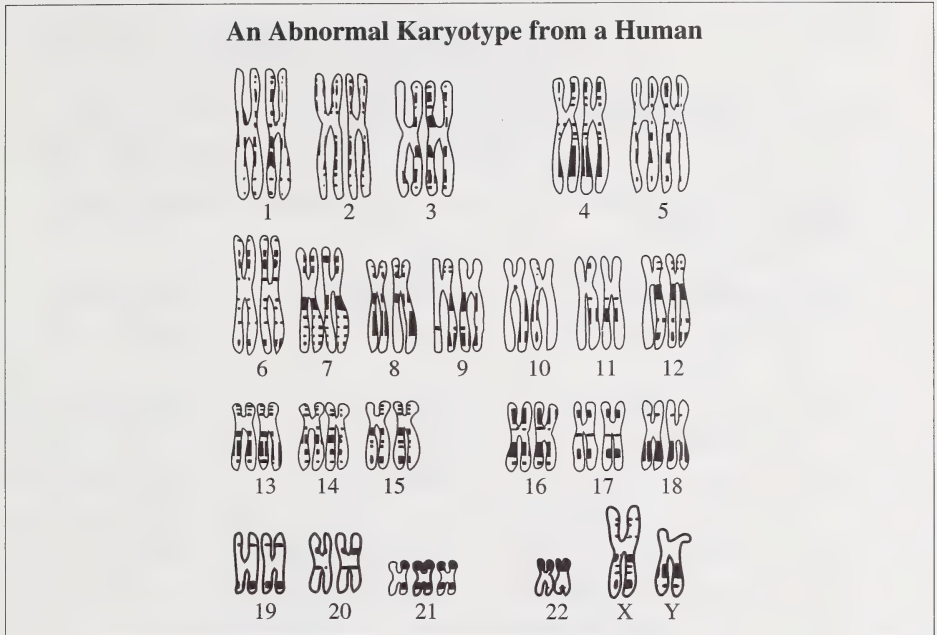
Use the following information to answer the next question.

**Events That Occur During DNA Replication
(Arranged in Random Order)**

- 1 Hydrogen bonds form between nucleotide bases.
- 2 An enzyme acts like a pair of scissors to break the weak hydrogen bonds between the nitrogen bases.
- 3 At the replication fork, the DNA template strands determine the sequence of the nucleotides that are being replaced.
- 4 A purine or pyrimidine is inserted on a matching nucleotide of the polynucleotide strand.
- 5 Nitrogen bases of the polynucleotide strand separate.

38. The correct sequence of events that occurs during DNA replication is
- A. 2, 3, 5, 1, and 4
 - B. 2, 5, 3, 4, and 1
 - C. 3, 2, 5, 4, and 1
 - D. 3, 5, 2, 1, and 4

Use the following diagram to answer the next two questions.



39. What is a likely cause of the abnormality shown in this karyotype?
- Crossing over of autosomes
 - Nondisjunction of autosomes
 - Crossing over of sex chromosomes
 - Nondisjunction of sex chromosomes
40. Which technology would be best suited to identify a fetus with this disorder?
- Ultrasound
 - X-ray imaging
 - Amniocentesis
 - DNA fingerprinting

Use the following information to answer the next question.

Some Characteristics of Cell Division

- 1 DNA is replicated just before cell division begins.
- 2 Duplicated chromosomes pair with their homologues.
- 3 Diploid cells are ultimately produced.

41. Which row correctly identifies the type of cell division described by each numbered statement?

Row	Statement 1	Statement 2	Statement 3
A	both mitosis and meiosis	meiosis only	mitosis only
B	both mitosis and meiosis	both mitosis and meiosis	mitosis only
C	mitosis only	meiosis only	both mitosis and meiosis
D	mitosis only	both mitosis and meiosis	meiosis only

Use the following information to answer the next two questions.

In shorthorn cattle, coat colour may be red, white, or roan. Crosses between a red bull and a white cow produce only roan offspring.

42. The alleles for coat colour in shorthorn cattle demonstrate
- A. sex-linkage
 - B. crossing over
 - C. codominance
 - D. nondisjunction

Numerical Response

5. If a roan shorthorn is crossed with a white-coated shorthorn, what is the probability that the offspring will be a roan shorthorn?

Answer: _____

(Record a value from 0 to 1 rounded to two significant digits in the numerical-response section of the answer sheet.)

Use the following information to answer the next three questions.

In guinea pigs, black coat (B) is dominant over white coat (b), and straight hair (S) is dominant over curly hair (s). Each pair of alleles assorts independently.

Two guinea pigs mated. The types of gametes produced by the parents are shown in the Punnett square. Possible genotypes of offspring resulting from the mating are indicated in the centre of the Punnett square as genotype 1 to genotype 8.

♀ \ ♂	BS	Bs	bS	bs
Bs	genotype 1	genotype 2	genotype 3	genotype 4
bs	genotype 5	genotype 6	genotype 7	genotype 8

43. Which row correctly identifies the phenotypes of both parents?

Row	♂	♀
A	black–straight	black–curly
B	black–straight	black–straight
C	black–curly	white–straight
D	white–curly	black–straight

44. The Punnett square indicates that the parent guinea pigs
- produced eight offspring, all with different genotypes
 - produced eight offspring, half of which have at least one of the dominant traits
 - are likely to produce a higher proportion of offspring with black coats than offspring with curly hair
 - are likely to produce a higher proportion of offspring with white coats than offspring with straight hair

Numerical Response

6. Choose the correct genotype number for each description of guinea pig offspring.

Genotype number:			
Description of offspring:	Homozygous recessive for both traits	Have the same genotype as genotype 3	White coat colour and heterozygous for hair type

(Record your three-digit answer in the numerical-response section of the answer sheet.)

45. A new insecticide functions as a mutagen. It seems to have little effect when applied to an adult insect population. However, the insect's offspring have a variety of lethal defects. This new insecticide likely affects the process of
- A. mitosis in gonads
 - B. meiosis in gonads
 - C. mitosis in somatic cells
 - D. meiosis in somatic cells

Use the following information to answer the next three questions.

Phenylketonuria

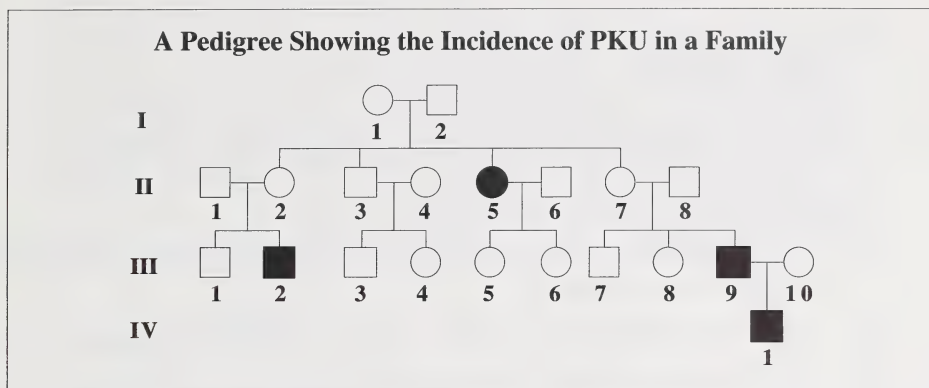
Phenylketonuria (PKU) is a genetic disorder, the symptoms of which result from the inability of a person to produce the enzyme necessary to metabolize the amino acid phenylalanine. Production of the normal enzyme is controlled by a dominant allele. Without this enzyme, phenylalanine accumulates in a person's body and causes mental retardation by inhibiting the normal development of the nervous system.

The symptoms of PKU are not usually evident immediately at birth, but develop rapidly after birth if an affected child is not put on a special diet. After ten years of age, the nervous system is fully developed and the child's diet need no longer be strictly controlled.

46. The initial cause of PKU in an affected child likely results from the presence of abnormal
- A. ribosomal RNA
 - B. messenger RNA
 - C. DNA in cell nuclei
 - D. DNA in cell mitochondria

Continued

Use this additional information to answer the next two questions.



47. Which is a valid conclusion about the genotypes for the alleles for PKU of individuals II, 2 and II, 3?
- They are both heterozygous because their sister has PKU.
 - They are both homozygous–dominant because their parents have normal phenotypes.
 - Without further evidence, it cannot be determined if both are homozygous–dominant or heterozygous.
 - Without further evidence, it cannot be determined if both are homozygous–recessive or heterozygous.

Numerical Response

7. If the individuals in this pedigree represented a distinct population, how many of the 21 people could be expected to be heterozygous for PKU?

Answer: _____ people

(Record your answer in the numerical-response section of the answer sheet.)

Use the following information to answer the next two questions.

Hemophilia is a disorder characterized by abnormal blood clotting. This disorder is an X-linked recessive trait.

48. A man who does not have hemophilia, but whose father did, is married to a woman who has no history of hemophilia in her family. Would genetic screening be necessary if this woman gets pregnant?
- A. No, because there is little probability that the disorder would occur regardless of the sex of the offspring.
 - B. Yes, because the man's father had hemophilia and it may skip a generation.
 - C. No, because there is only a 25% chance that a male child would get the disorder.
 - D. Yes, because there is a high probability of mutation for X-linked genes.

Numerical Response

8. A normal woman whose father had hemophilia is married to a man who has hemophilia. If they have a child, what is the probability that the child would have hemophilia?

Answer: _____

(Record a value from 0 to 1 rounded to two significant digits in the numerical-response section of the answer sheet.)

Use the following information to answer the next question.

In the 19th century, individuals who were not among the “normal” population were often thought to be failures or defectives. Early in the 20th century, the interaction of genetics, law, and society resulted in policies of enforced sterilization, restrictive immigration, and institutionalization of those thought to be genetic defectives. As this century closes, society will have difficult choices to make about the legality, morality, and economics of applying genetic knowledge and technology. The difficulty of this situation is summarized in the words of a famous geneticist, Theodosius Dobzhansky (b.1900 – d.1975):

“If we enable the weak and the deformed to live and produce more of their kind, we face the prospect of a genetic twilight (decline). But if we let them die or suffer when we can help them, we face the certainty of a moral twilight.”

Written Response – 12 marks

2. Consider the following proposal:

People with genetic abnormalities should not be discouraged from having families. Doctors should attempt to treat every genetically related health problem and to keep people alive at all cost.

If this proposal were initiated, there would be many effects on our society. Describe three ethical medical technologies that would reduce the financial costs created by initiating this proposal. Evaluate the proposal from both a genetic and a moral point of view.

Your response should include the following information:

- A description of three medical technologies that are ethical and that would likely reduce some of the financial costs created by initiating the proposal
- A balanced argument for and against the proposal from the scientific perspective of a geneticist
- A balanced argument for and against the proposal from the perspective of a policy maker (e.g., a politician or a religious leader)

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You have now completed the examination. If you have time, you may wish to check your answers.

BIOLOGY DATA

Symbols

Symbol	Description	Symbol	Description
A	area	$>$	greater than, dominant over
B	births during time interval	$<$	less than, recessive to
b	per capita births (B/N)	$=$	equal to, codominant with, incompletely dominant with
D	deaths during time interval	$/$	divided by, "out of"
d	per capita deaths (D/N)	\times	multiplied by, times, crossed with, mated with
D_p	population density	Δ	change
K	carrying capacity	♂	male
N	population size	♀	female
ΔN	change in population size	n	chromosome number
$PG\%$	population growth (percent)	I^A, I^B, i	alleles (human blood type) ABO system ($I^A = I^B, I^A > i, I^B > i$)
r	per capita population growth rate ($b - d$)	t	time
V	volume	Δt	change in time

Equations

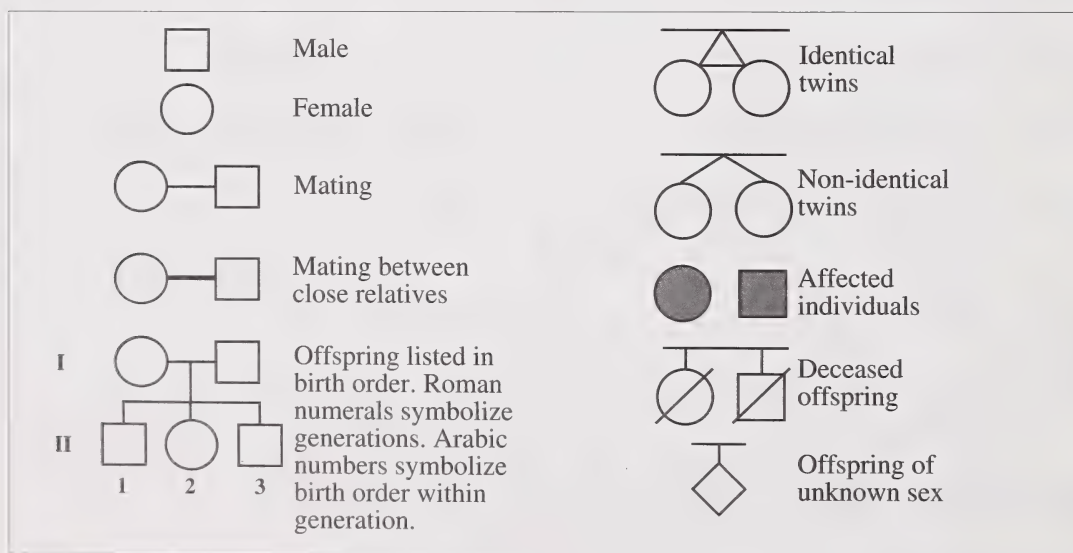
Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{V}$ or $D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Population growth (%)	$PG\% = \frac{\Delta N \times 100\%}{N}$

BIOLOGY DATA

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols



BIOLOGY DATA

Messenger RNA Codons and Their Corresponding Amino Acids

S E C O N D B A S E												
U				C		A		G				
F	U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U	T	
		UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	C		
		UUA	Leu	UCA	Ser	UAA	STOP**	UGA	STOP**	A		H
		UUG	Leu	UCG	Ser	UAG	STOP**	UGG	Trp	G		
R										I		
S	C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U	R	
		CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	C		
		CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	A		D
		CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	G		
T	A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U	B	
		AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	C		
		AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	A		
		AUG	Met or START*	ACG	Thr	AAG	Lys	AGG	Arg	G		
A										A		
S	G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U	S	
		GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	C		
		GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	A		E
		GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	G		

* Note: AUG is an initiator codon but also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Abbreviations for Amino Acids

Amino Acid	Abbreviation
Alanine	Ala
Arginine	Arg
Asparagine	Asn
Aspartate	Asp
Cysteine	Cys
Glutamate	Glu
Glutamine	Gln
Glycine	Gly
Histidine	His
Isoleucine	Ile
Leucine	Leu
Lysine	Lys
Methionine	Met
Phenylalanine	Phe
Proline	Pro
Serine	Ser
Threonine	Thr
Tryptophan	Trp
Tyrosine	Tyr
Valine	Val

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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